DOCUMENT RESUME

ED 404 160 SE 059 685

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TITLE A Survey of the Use of Science Manipulatives in Elementary Schools.
PUB DATE 6 Nov 96
NOTE 16p.; Paper presented at the Annual Meeting of the Mid-South Education Research Association (Tuscaloosa, AL, November 6, 1996).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Elementary Education; *Elementary School Science; *Hands on Science; Inquiry; Inservice Teacher Education; *Manipulative Materials; *Science Education; *Scientific Attitudes; Surveys

ABSTRACT

The research question used for this study was Can elementary classroom teachers identify "familiar" science manipulatives as well as the availability of manipulatives and percentage of time they are used in their classroom? Questions were also asked to determine factors that influence manipulative use, science units that are appropriate for the incorporation of manipulatives, and whether manipulative use spans all elementary grade levels. The subjects were 143 teachers from elementary schools throughout the largest school district in southwest Alabama. Although teachers showed a relatively high familiarity with with certain manipulative aids, the availability of these aids for the classrooms was low. In conjunction with familiarity and availability, the use of manipulatives occurred in less than 20% of the school days. Since science is taught on the average of one period per day, the results indicate that manipulatives are used in only one of the five periods per week. Hence, overall science manipulative use in this study appears minimal. The authors argue that manipulatives are important for developing scientific inquiry skills, and they suggest additional inservice teacher education in the use of science manipulatives. The manipulatives questionnaire is included as an appendix. (PVD)

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ED 404 160

# A Survey of the Use of Science Manipulatives in Elementary Schools

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A paper presented at the annual meeting of the Mid-South Education Research Association, Tuscaloosa AL, November 6-8, 1996

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## Science Manipulatives

The advocation of the use of science manipulatives in the classroom is not a new phenomenon. Manipulatives assist students in scientific investigations and in the mastery of scientific information. In Science for All Americans (1990) it was stated that manipulatives and observation skills should be acquired "to handle common materials and tools for dealing with household and other everyday technologies, for making careful observations, and for handling information" (p.179).

The National Science Education Standards (1995) advocates the use of manipulatives by stating, "Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing, and analyzing alternative explanations and communicating scientific argument ." (p.l05) Students should be encouraged to develop their scientific inquiry skills through investigations, involving manipulatives, within their cognitive development level. Young children "can design investigations to try things to see what happens ... they tend to focus on concrete results of tests and will entertain the idea of a "fair" test (a test in which only one variable at a time is changed)." (p.121)

Curriculum reform in elementary science education has occurred since the launch of Sputnik in 1957. The "alphabet" science programs were designed with active involvement by teachers and students, using manipulatives, to discover new scientific information (at least to the student) and mastery of process skills. Research has been done on the effectiveness of these programs (Wideen, 1975; Davis, Raymond, MacRawls, & Jordan, 1976; Vanek and Montean, 1977) versus traditional teaching strategies.

Debate continues as to whether manipulative based, hands-on programs, are effective in classrooms. Stohr-Hunt (1996) reported "that students who experienced hands-on activities frequently had significantly higher scores of science achievement than those students who experienced hands-on science infrequently" (p.105). It was recommended that teachers "should be concerned with actively motivating and involving students in experiences that will in some way extend the students' knowledge ..." (p.107)

The question arises as to the impact of the type and frequency of use of science manipulatives. In a study involving elementary teachers, identification of (grade level, teaching experience) math manipulatives, variables related to manipulative use and factors teachers consider when using manipulatives to teach, Hatfield (1994) stated that teachers could identify manipulatives but actual manipulative use was low. Additionally, manipulation use declined as the grade level increased. Although this study was done with math manipulatives, it can be inferred that similar results would be found using science manipulatives.

The research questions for this study were: Can elementary classroom teachers identify, "familiar" science manipulatives, the availability of, and percentage of time used in their classroom? In addition, questions were asked to determine factors that influence manipulative usage, science units that are appropriate for the incorporation of manipulatives, and if manipulative usage spans all elementary grade levels.

## Methods

A questionnaire was developed by the researchers using a format developed by Hatfield (1994) (see Appendix). The survey had several sections: demographic data, factors that influence science manipulative use, science units appropriate for manipulative use, and identification, availability, and percentage of time used in the classroom of science manipulatives. The questionnaire took approximately 15 minutes to complete.

The demographic data focused on the grade level, class size, total years of teaching, years at the present grade level, how often science is taught, and two open-ended questions on current science text and supplemental texts used.

The factors influencing the use of manipulatives, units appropriate for manipulative use, and identification, availability, and percentage of time used were constructed by a team of pre-service and in-service teachers and elementary science educators. The list of manipulatives included two distracters, metric rods and flexi weights, to determine teachers' acquiescence bias to the survey (Hatfield, 1994).

The 143 subjects in the study were teachers from elementary schools throughout the largest school district in southwest Alabama. Teachers were of various ages, gender, educational levels, number of years taught overall and at their present grade level. The schools were of various SES levels, student populations, racial compositions, and location within the school district. All participation was voluntary and anonymous.

Data were collected, tabulated, entered, and analyzed using Statistical Program for the Social Sciences (SPSS). Frequencies, Chi-squared, and independent t-tests were used to analyze the data.

## Results

The demographic data indicated that 75% of the teachers taught kindergarten through third grade. Teaching experience ranged from one to 34 years with 10.5 years as the average amount of teaching experience and an average of eight years at their present grade level. Class size ranged from six to 34 students, with 17 students being the average class size. One period (85%) was the most common number of periods of science taught per day. Discovery Works, a science manipulative oriented textbook series, was the most commonly identified series. Project Learning

Tree and AIMS were identified as supplemental science curricula used, but by only five percent of the teachers in the study (See Table 1).

The factors most often identified for using manipulatives were availability (81%) and classroom control/noise level (65%) (See Table 2). The units in which teachers indicated manipulative usage were: magnetism (90%), simple machines (87%), and sound (80%). (See Table 3)

The manipulative aids with which teachers indicated having a 90% or higher familiarity with were: thermometers (99%), magnets (98%), microscopes (97%), medicine droppers (94%), and hand lens (93%). (See Table 4) The trundle wheel (23%) and flexi weights (25%) were least familiar to teachers. Manipulative aids, metric rods and flexi weights received a 61% and 25% familiarity rating although neither aid actually exist.

The manipulative aids most available to teachers were magnets (83%) and thermometers (80%). The least available were trundle wheels (6%), flexi weights (15%), and metric rods (36%).

Manipulative usage by teachers was restricted to 0-20% of school days (57%). The manipulatives used between 21-40% of school days were: thermometers (18%), magnets (16%), graduated cylinder, hand lens (14%), and prism (12%). Only the use of magnets and thermometers were indicated from 41-100% use. The least used object was the flexi weights (55%).

Chi-square and t-test analyses revealed no significant differences. Due to the small sample size of grades four, five, and six, any significance would have been skewed.

## Discussion

The results of this study do not coincide with the results of Hatfield's study (1994). Manipulative use in elementary schools appears to be minimal. Although there is a large sample

size in this study, results are tentative due to the large number of primary grade participants. Any comparisons of grades K-3 to grades 4-6 cannot be done without the results being skewed.

The availability of science manipulatives and the noise factor associated with their usage are primary concerns of teachers. This is often a reflection of the administrations' view of the lack of or the importance of manipulative usage (time on task, actual learning, noise might indicate a lack of learning) and the budget restraints facing many school districts. It is interesting to note that teacher competency in using science manipulatives was not considered a factor prohibiting usage.

The two units, magnets and simple machines, identified by teachers are ones in which manipulatives are readily available and of low cost. These manipulatives can be found as household products and teachers feel comfortable using them. The new science series Discovery Works is a hands-on, manipulative based curriculum being introduced to this school district this year. This may explain why this was the dominant science textbook series identified in the survey. The new textbook series may alleviate future concerns about the lack of manipulative availability and could contribute to the use of manipulatives in other units.

The majority of the teachers in this study were familiar with the manipulative aids listed in the survey. Thermometers and magnets were the most familiar with the trundle wheel and flexi weights as the least familiar. Again, the availability of thermometers and magnets would influence teachers' familiarity with them.

The two non existent manipulative aids, flexi weights and metric rods, were included to determine teachers' acquiescence response bias. Teachers indicated they were not familiar with flexi weights but two thirds were familiar with metric rods. Some confusion may exist due to teachers believing metric rods are meter sticks. There are metric weights in various shapes that are bendable which may have caused teachers to believe they were familiar with flexi weights.

Although there was a relatively high familiarity with certain manipulative aids, the availability of these aids for their classrooms was low. It appears teachers can identify certain science manipulatives but do not have access to them in their classroom. In conjunction with familarity and availability, the use of manipulatives occurs less than 20% of the school days. Science is taught, on average, one period per day and the results would indicate that manipulatives are used in only one of the five periods per week. These results are similar to Hatfield (1994) in that math manipulative usage was 5.3 days per month. Although t-test indicated a significant difference between primary and intermediate grades in Hatfield's study, those results were not found in the present one.

Overall science manipulative use in this study appears minimal. With the relative restricted availability of manipulatives, students are being placed at a disadvantage for mastery of current and future science concepts. Besides the handicapping of students in the mastery of science, negative attitudes by students toward science may form.

Additional inservice in the use of science manipulatives would be indicated. Besides teachers, administrators should be included in the inservices so the importance of manipulative use can be demonstrated. Additional funding, in the form of Eisenhower grants or local grants for science manipulatives, should be sought. Inservice for using Discovery Works, with the manipulatives, should be done with monthly follow-ups.

Further research should include additional subjects in grades 4-6 so that comparisons between primary grade and intermediate grade teachers can be made. Follow-up interviews with participants should be carried out for clarification of responses and guide in future inservice.

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**Table 1**

**Demographic Data**

N=143

Grades: Kindergarten through sixth plus special education.

| | | | |
|---|---|---|---|
| Grade level: | Kindergarten | = | 31 |
| | One | = | 30 |
| | Two | = | 26 |
| | Three | = | 20 |
| | Four | = | 15 |
| | Five | = | 18 |
| | Six | = | 1 |
| | Special Education | = | 1 |

Class size: Range 6 to 34 students with a mean of 17 students.

Total years teaching: Range 1 to 34 years with a mean of 10.5 years.

Years at present grade level: Range 1 to 26 years with a mean of 8 years.

Number of science periods taught per day (percentage)

| | | | | | |
|---|---|---|---|---|---|
| One | = | 85 | Four | = | 1 |
| Two | = | 4 | Five | = | 1 |
| Three | = | 1 | Integrated | = | 5 |

**Table 2**

**Factors to be considered in using manipulatives to teach science**

| Factors | Percentage Agree |
|---|---|
| Classroom control/noise level | 65 |
| Availability | 81 |
| Time factors-time needed to cover textbook | 50 |
| Teacher competency in teaching science | 49 |
| Management of manipulatives | 60 |
| Students "play" with manipulatives rather than learn | 40 |
| Transfer of learning | 52 |

**Table 3**

**Science units that manipulative use would be indicated**

| Unit | Percentage |
|---|---|
| Electricity | 61 |
| Magnetism | 90 |
| Simple Machines | 87 |
| Process Skills | 55 |
| Sound | 80 |
| Experimenting | 77 |
| Light | 77 |

**Table 4**

**Teachers Reporting Familiarity with and Availability of Science Manipulatives**

| Device | Familiar | Available |
|---|---|---|
| Trundle wheel | 23 | 6 |
| Platform balance | 73 | 41 |
| Thermometer | 99 | 80 |
| Microscope | 97 | 63 |
| Hand lens | 93 | 75 |
| Metric rods * | 61 | 29 |
| Beaker | 88 | 52 |
| Prism | 91 | 55 |
| Flexi weights * | 25 | 15 |
| Medicine dropper | 94 | 71 |
| Graduated cylinder | 85 | 52 |
| Tuning fork | 76 | 40 |
| Magnets | 98 | 83 |

* Non-existent device n = 143

# Appendix

## MANIPULATIVES QUESTIONNAIRE

School _____

Grade Level: _____
Class size: _____
Total years teaching: _____

Years teaching present grade level: _____
Number of science periods taught per day: _____
Present science text (s): _____

Supplemental science texts or materials used regularly (i.e. AIMS, GEMS, FOSS, PROJECT LEARNING TREE, WILD, WET)

_____

Factors to be considered in using manipulatives to teach science are:

Check (√) all that apply and circle the **most** important factor.

____ Classroom control/noise level
____ Availability
____ Time factors-time needed to cover textbook
____ Teacher competency in teaching science using manipulatives
____ Management of manipulatives
____ Students "play" with manipulatives rather than learn from them
____ Transfer of learning from concrete to symbolic level

Units I would use manipulatives for: (√)

____ Electricity
____ Magnetism
____ Simple Machines
____ Process Skills
____ Sound
____ Experimenting
____ Light



Consider each manipulative aid for teaching science. Check (√) your response to each category.

| | Are you familiar with it? | | Is the manipulative available? | | Percent of school days you use it | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Manipulative Aid | Yes | No | Yes | No | 0-20% | 21-40% | 41-60% | 61-80% | 81-100% |
| Trundle wheel | | | | | | | | | |
| Platform balance | | | | | | | | | |
| Thermometer | | | | | | | | | |
| Microscope | | | | | | | | | |
| Hand lens | | | | | | | | | |
| Metric rods | | | | | | | | | |
| Beaker | | | | | | | | | |
| Prism | | | | | | | | | |
| Flexi weights | | | | | | | | | |
| Medicine dropper | | | | | | | | | |
| Graduated cylinder | | | | | | | | | |
| Tuning fork | | | | | | | | | |
| Magnets | | | | | | | | | |